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SCORPION NOMENCLATURE AND MENSURATION[1]

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One of our serious academic problems is the increasing break-down in inter-disciplinary communication. As disciplinary splintering occurs the jargon increases and the house of academia is becoming more and more like the proverbial Tower of Babel.

Systematists of the order Scorpionida are not only guilty of this type of deviation but, with an increasing interest in the area, scorpiologists and para-scorpiologists are creating a Tower of Babel of their own. In order to co-ordinate scorpion nomenclature within the order and with that of other areas of arthropodology, the basic terminology of Snodgrass (1952) is recommended. Since this would not include all structures important in scorpion systematics other terms used currently are presented together with nomenclature for structures heretofore referred to in sometimes vague, generalized terms. The general structures are illustrated in Figures 1 and 2[3]. In order to assist the novice in interpreting some of the older, as well as some of the current literature, a comparative nomenclatural, columnar table is presented. English synonyms or other equivalents are indicated in parentheses in column two. Equivalents in French, German, and Spanish are given in columns 3-5 respectively. The French nomenclature is almost entirely that of Vachon (1952); the German, primarily after Kraepelin (1899) and Werner (1935); the Spanish after Hoffman (1931, 1932). The author gratefully acknowledges the assistance of M. deVerde in completing the Spanish equivalents.

Procedures in mensuration are given for two reasons. First, the large numbers of heavily sclerotized structures make possible the obtaining of

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[3]All label numbers are in reference to those in the "code number" column of Table 1.

accurate quantitative data. Second, quantitative data can present a more precise concept of genetic relationships while pointing up sexual dimorphism and revealing allometric development. The latter type of information is extremely important.

The scorpion body divisions can be thought of in various ways (Figs. 1 and 2). The anterior broad portion, including the unsegmented carapace and the following seven segments, is referred to as the **trunk** and the following six segments as the **tail** or **cauda**. The trunk consists of the **cephalothorax** and the **preabdomen** while the cauda is composed of five **postabdominal** segments plus the sting bearing **telson**.

The cephalothorax is also called the **prosoma** while the rest of the body, i.e., the pre- and postabdomen plus the telson, is called the **opisthosoma**. This "hind portion" of the animal is further divided into the **mesosoma** (preabdomen) and the **metasoma** (postabdomen plus telson or cauda).

The **carapace**, an unsegmented sclerotized plate covering the cephalothorax, is a very revealing structure in systematics. Its general contour, the

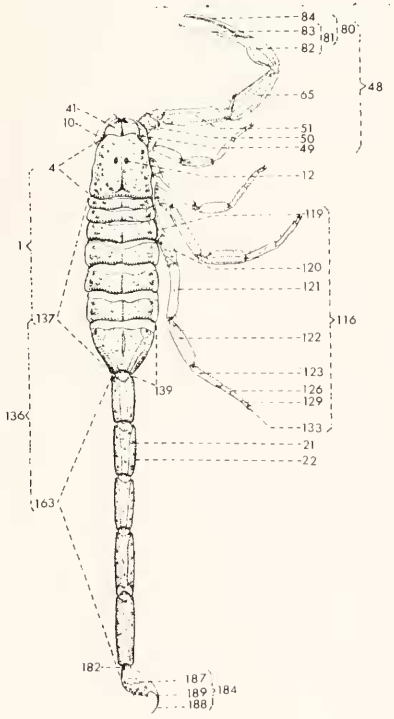

Figure 1. Dorsal aspect of generalized scorpion. (See Table 1 code numbers for label numbers.

surface features, as well as the size and spatial relationships of the median and lateral eyes are helpful. The nature of the anterior margin, whether it is concave, straight, or convex is significant. The ratio of the anterior width, to the median or posterior width can be important as well as the anterior-posterior divergence.

The following carapacial measurements are important since this structure is not generally subject to allometric development:

1. **Length** Distance between the anterior and posterior margins along the longitudinal axis. If either margin is lobed, the measurements are made from a line tangent to those lobes. All measurements are made with an ocular, metric reticle.
2. **Anterior width** The distance between the exterior margins of the first pair of lateral eyes (Fig. 3).
3. **Median width** Lateral margin to margin distance at level of anterior margin of median eyes.
4. **Posterior width** Greatest lateral margin to margin distance in posterior portion of carapace. In dried or poorly preserved specimens this measurement may not always be reliable due to a tendency of this carapacial curvature to change its arc.
5. **First lateral eyes to median eyes** Distance between adjacent margins of these eyes.
6. **Median eyes to anterior margin** Distance from anterior margin, as above described, to anterior margin of median eyes.
7. **Median eyes to posterior margin** Distance from *anterior* margin of median eyes to posterior carapacial margin, as described above.
8. **Width of median ocular tubercle** The distance between the exterior margins of the median eyes.

The anterior-posterior divergence is obtained by dividing the quantity, posterior width minus anterior width, by the carapacial length.

Surface features that are important, besides the size and density of the granules or tubercles or the possible reticular or/and punctate conditions, are the nature and presence of furrows and keels. These (furrows: Nos. 16-26; keels: Nos. 28-34) are illustrated in Figure 3.

The shape of the sternum (Figs. 2 and 4 A-D) plays an important role in distinguishing the higher categories but is of little value at the generic, or lower, level. Its contour is effected somewhat by allometric development. Such variation may prove a taxonomic pitfall.

The appendages of the prosoma consist of the chelicersa (kē-liś-er-a), pedipalps and walking legs. The first mentioned consists of a basal piece and a

chela. The denticles on the superior and inferior margins of the fingers may be important; the former generally at the generic level and the inferior sometimes at both the generic and species levels. The setaceous condition is of little taxonomic value.

The pedipalps are an excellent source of taxonomic data, both subjective and quantitative. They consist of the following subdivisions: coxa, trochanter, femur, patella, and chela (pincer) which is composed of the tibia, made of the manus (hand) and its finger, and the tarsus (movable finger) (Figs. 1 and 2). Considering the chelae in their natural position it is generally possible to recognize on the manus a superior, inferior, and exterior surface (the "Hinterhand" of Kraepelin; "face ventrale" of Vachon) (Fig. 5, ExS). Various ridges (crests), or keels, may be present on these surfaces. On the superior face, generally the most prominent crest is the **digital** keel (90). This is often in the form of an elongated S and may be prolonged medially along the tibial finger and divide the superior surface into **interior** and **exterior** areas. Sometimes the digital keel is so strongly developed as to place these two areas at approximately right angles to each other. Inwardly the superior and inferior surfaces

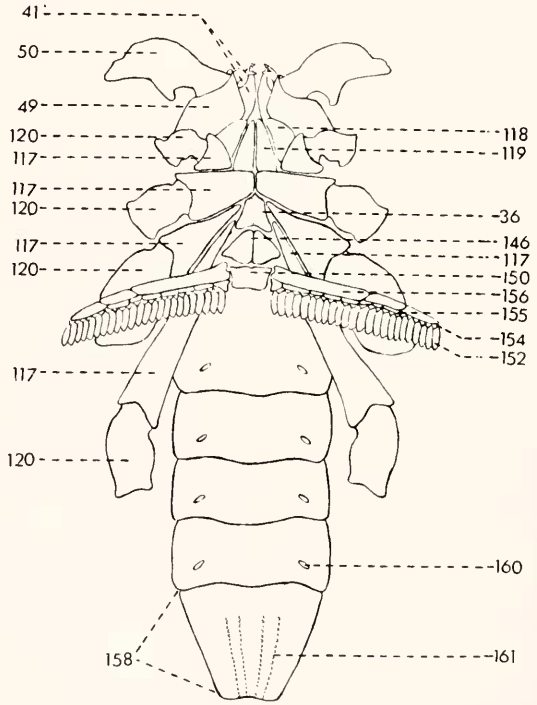

Figure 2. Ventral aspect of generalized scorpion.

are separated by the **interior marginal** keel (94). Along the other extreme margin of the superior surface is the **exterior marginal** keel (87) which in some taxa extends diagonally distad across the exterior surfaces (Ex S). Between the digital and the two marginal keels may be found additional, or secondary keels.

Moving inwardly from the digital keel may be the **sub-digital** keel (Fig. 5, 91), extending distally only part way along the manus surface. Next is the **inner secondary keel** (92) which is sometimes a prominent keel and may extend along the inner aspect of the tibial finger. Between this keel and the interior marginal keel may be a short **sub-inner secondary** keel (93).

Exteriorly from the **digital** keel is found first the **exterior secondary** keel (Fig. 5, 89). At times this ridge is sufficiently developed to cause the exterior area to be equivalent in height to the digital keel and produce a subcylindrical contour of the manus. The next keel, the **secondary accessory** (88), although generally vestigial, may extend over one-half the distal portion of the manus from the superior end of the tarso-tibial articulation.

There are fewer keels on the inferior surface. An **inferior digital** may be recognized as well as an **inferior exterior** keel (Fig. 5, 100) and an **inferior secondary** keel. These are not often of taxonomic value.

The keels and intercarinal spaces may have surface features of considerable taxonomic value. These will be discussed later.

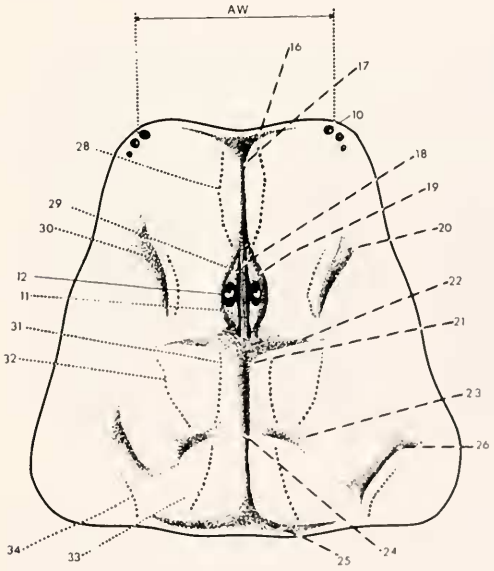

Figure 3. Generalized carapace. A. W.=Anterior Width.

The cutting edge of the tibial finger and tarsus may bear different shapes and patterns of granules, tubercles, denticles, and lobes. The accompanying figures illustrate two of the common patterns (Figs. 6 and 7).

The segment proximad from the tibia is the **patella**, forming the "bend" in the pedipalp. Of taxonomic importance are the state of development of its eight keels, the surface features of these keels, and the intercarinal areas.

Proximad from the patella and at about right angles to it on a resting scorpion, is the somewhat more elongate **femur.** The chela, patella, and femur simulate a U-formation. Like the patella, its keels (seven) and the formations on them

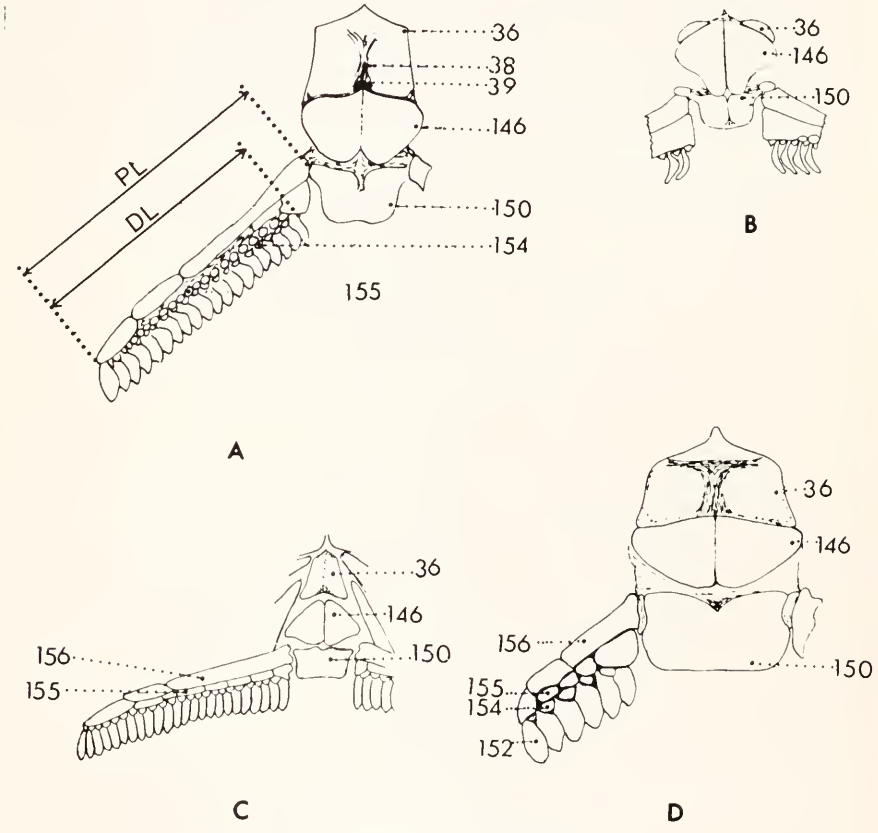

Figure 4. Sternum, genital operculum and pectines. A. *Vejovis spinigerus* (Wood), PL = Pecten Length; DL = Dentate margin Length. B. *Bothriurus* sp. C. *Centruroides sculpturatus* Ewing. D. *Superstitionia donensis* Stahnke.

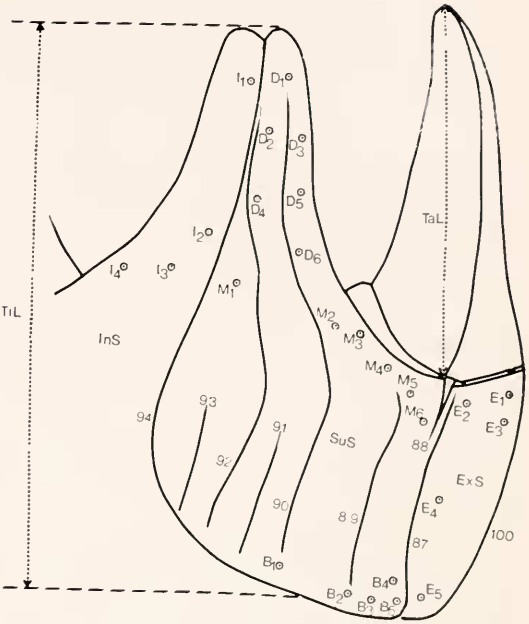

Figure 5. Generalized pedipalp chela. TaL=Tarsus Length; TiL=Tibia Length; InS=Inferior Surface; SuS=Superior Surface; ExS=Exterior Surface. I_1, etc.=Inferior, D_1, etc.=Digital, M_1, etc.=Manus, B_1, etc.=Basal, E_1 etc.=Exterior trichobothria. Code numbers=keels.

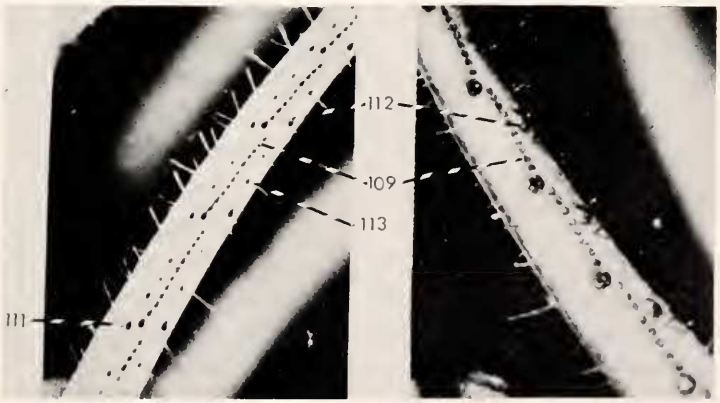

Figure 6. Centuroides sculpturatus Ewing pedipalp tarsus cutting edge. Supernumerary granules (113) include all those between the larger lateral granules.

Figure 7. Hadrurus hirsutus (Wood) pedipalp tarsus cutting edge.

and in the intercarinal spaces may be of taxonomic value.

The trochanter and coxa are of little taxonomic importance.

The dimensions of the pedipalp structures and how they are obtained are given below:

1. **Total length** The value used is the sum total of the respective lengths of the femur, patella, and tibia. The coxal and trochanter length are omitted because of their irregular form which would lend to errors and make measurement meaningless.
2. **Tibia length** Shortest distance from proximal margin at point of tibiopatellar articulation, approximately through trichobothrium B_1, to distal tip of finger. See Figure 5 (TiL).
3. **Manus length** From proximal margin at point of articulation (as in 2 above) to digital commissure.
4. **Manus width** Greatest interior to exterior marginal width.
5. **Manus thickness** Greatest distance between inferior and superior surfaces.
6. **Exterior surface length** From proximal margin of manus through trichobothrium E_5 to the line of tarso-tibial articulation.
7. **Tarsus length** The shortest distance from the most superior point of the tarso-tibial articulation to the most distal point of the tarsus. (See Fig. 5, TaL).
8. **Patella length** The length of the non-telescoping portion along the dorsal surface.
9. **Patella width** Greatest, basic width at mid-way between distal and proximal margins. This is not a very practical or precise measure because of unusual protuberances on the inner surface in some taxa.
10. **Femur length** The length of the non-telescoping portion along the dorsal surface.
11. **Femur width** Greatest width at distal one-third.

The walking legs consist of the coxa, trochanter, femur, patella, tibia, tarsus (consisting of tarsomere I and tarsomere II, the foot) and the pretarsus. This last segment is quite inconspicuous but bears two **lateral claws** and a **ventro-median claw**. (Fig. 8).

The legs occasionally are of taxonomic importance. For example, bristlecombs are generally found on the lateral aspect of the tarso-tibial leg segments of psammophilic species. The comparative lengths and widths of the tibia and tarsomere I of leg IV frequently are helpful taxonomic indicators; as is the total length of leg IV. This quantity would not include tarsomere II and the pre-tarsus. These structures frequently would be difficult to measure and their

inclusion would not make the quantity more meaningful.

Some rather inconspicuous leg structures (Fig. 8) (tibial spur, pedal spur, bristles, etc. on tarsomere II and the pretarsus) have proven to be of considerable taxonomic significance. The **tibial spur** (124), found in the tibio-tarsal connective tissue, is present in some Buthidae but absent on others. The **pedal spurs** (127), located in the connective tissue between tarsomere I and II are present on all scorpions[4] However, on some taxa there may be one present on both exterior and interior aspects while on others only an exterior spur is present. Again a spur may be forked or have 4 or 5 lateral subdivisions. The sole of tarsomere II may bear various projections. These may be small pads, long setae or stout spines. In the latter case there may be a double row with the number on the exterior and interior margins varying from each other but constant for a given taxa. In some taxa this number is constant on each pair of legs but may be variable from leg pair to leg pair. The **median lobe** of tarsomere II varies in length, shape and number, and position of terminal setae from taxon to taxon. The **lateral lobes** may be strongly convex, bearing spines on their margin, or almost straight. The **median claw** of the pretarsus may vary in length between taxa. This may be true also of the **lateral claws.**

The anterior portion of the opisthosoma, the **mesosoma**, consists of seven segments. Each one is covered dorsally by a sclerotized plate, a **tergite**, which has an anterior transverse raised portion, the **pretergite**. This is often hidden

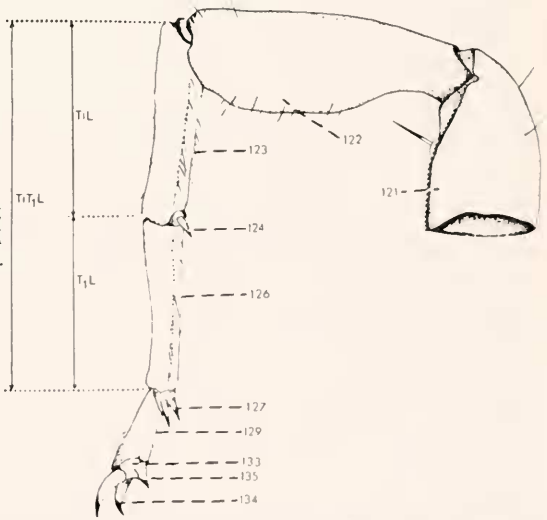

Figure 8. Generalized leg IV. TiT_1L=Tibia+tarsomere I length; T_1L=Tarsomere I length; TiL=Tibia Length.

[4]Two species are now known to lack pedal spurs: *Oecliis purvesi* L. Becker, 1880 (Diplocentridae) and a new troglobite scorpion, *Typhlochaetus rhodesi* Mitchell, 1968 (Chactidae).

by the over-lap of the anterior tergite in a poorly fed scorpion. The tergites become progressively longer from anterior to posterior. The first six frequently have very nearly the same surface features, i.e., similar granules, punctations, keels, etc. These tergites may bear from one to five keels. Tergite VII usually narrows abruptly posteriad so that its posterior width is about equal to that of the first caudal segment (Figs. 1 and 2). The surface features are usually markedly different from the first six. It is generally more coarsely granular and bears at least vestiges of three to five keels. Setae are generally few on all tergites and have little taxonomic value.

Only segments III-VII are completely covered ventrally by sclerotized plates, the **sternites** (Fig. 2). Segment I has a remnant in the form of two small sclerotized plates, the **genital opercula**. These are frequently united medially in the female and completely or partially separated in the male. They cover the genital aperture, the **gonotreme**, and on the male may partially or completely cover two genital papillae. These papillae vary in size on an inter-taxon basis and may be absent on some taxa. The sternite of segment II is represented by a small sclerotized plate, the **basal piece** (Fig. 2 and 4), which serves as a point of attachment and articulation of the pectens. It has some taxonomic value at the species level and may be helpful in sex determination.

The connective membranes between the genital area and the basal piece are referred to as the **post-genital** fold; that posterior to the basal piece as the **post-basal** fold. In some taxa the basal piece has a hinged accessory sclerotized posterior extension that folds inwardly on poorly fed scorpions. In satiated specimens this secondary portion is at the same level as the main body of the basal piece and gives a deceptive concept of its general configuration.

Sternites III to VI laterally bear a pair of respiratory apertures, the **stigmata** (Fig. 2). These may be circular, elliptical, or slit-like in shape; differences that are usually significant in the higher categories. These sternites seldom are granular, generally only sparsely hirsute and without keels. Sternite VII frequently is granular and may have two pair of lateral keels and a pattern of macrochaetes (Fig. 2).

The tergites and sternites laterally are bound together by the **plural** membranes. In lighter colored taxa these membranes may contain a black pigment which may be of specific significance.

The length of the mesosoma may be measured in two ways. Often this is simply an over-all measurement. As such, the quantity has small value because its magnitude will depend on the condition of nourishment. In an engorged specimen the intersegmental membranes are fully stretched so that the respective terga and sterna are separated from each other by a considerable

distance. In a starved specimen, each tergite will over-lap the pretergite area of the one posterior to it. The only satisfactory method for determining the mesosoma length is to do so by taking the sum of the individual tergal lengths, measured along the median line and including only the sclerotized area; this will include the pretergite. The "over-all" length may be as much as 40% greater than the "sum total" length.

The pectens, whose tactile function is clearly established, show sexual dimorphism as well as inter-taxon variation. Considerable variation also occurs during maturation within a species in some taxa; especially in the males. Moving from the exterior to the interior margins the pecten consists of the following linearly arranged sclerotized structures (see Figs. 4 B-D and 9): Three marginal lamellae, median lamellae, sub-triangular fulcra and pectinal teeth. The median lamellae vary in shape and number in different taxa. In some cases they are numerous, small, vaulted, circular plates (Fig. 4B); in others they are few in number and of varying shapes (Fig. 4C). In a few taxa they are completely absent.

The fulcra are small subtriangular sclerites positioned between the base of the teeth. Each fulcrum may bear a cluster of macrochaetes, the number of which may have taxonomic value. However, caution must be exercised since the number varies with the age of the specimen.

The teeth vary in shape and number inter- and intra-sexually within the species. Inter-specific variation in shape and number also may be great. Some taxa have only three pectinal teeth while others have over forty. It is of interest to note that a reduction in number of teeth does not assure a subsequent reduction in over-all pectinal length. This is especially noticeable on females. Therefore, the ratio of pectinal length to dentate margin length is frequently valuable in determining sex differences as well as a part of the taxon characterization (Fig. 4B). On the ventro-anterior margin of each tooth are found numerous minute, stubby bristles, the **sensilla** (Fig. 9, 153). The number of these sensory setae is greater on males and shows inter-taxon variation.

Vachon (1952) calls our attention to the taxonomic importance of the dorsal side (nearest to the sternal surface, i.e., the side hidden from view) in some cases. The various sclerotized plates are not as sharply delimited. In some cases the fulcra are small circular, vaulted plates while in others they are pointed or bear either a macro- or microchaete. The teeth, likewise, sometimes bear setae of constant number. These dorsal structures, consequently, have taxonomic usefulness and because of their protected condition, are less likely to be destroyed through normal scorpion activities, handling or preservation.

The metasoma (or cauda) (Fig. 1) consists of five sclerotized rings, progressively increasing in length posteriad, plus the telson. Distinct tergites and sternites are not discernible. The cauda is of great systematic importance and possesses numerous structures providing variability. These consist of surface features, keels, and three-dimensional variations in size. A dorsal furrow, extending throughout the length of the postabdomen, varies in depth due to the degree of carinate development and shows sexual dimorphism.

The first four caudal segments may have the following five pairs of keels: Dorsals, superior laterals (Fig. 1, 21 and 22), median laterals, inferior laterals, and inferior medians. These show different degrees of development and ornamentation on the various segments. Some may be well developed but smooth, or bearing confluent granules, distinct tuberculate, truncated, spinous or serrate granules.

Caudal segment V is always the longest of the five; usually lacks the dorsal keels, the median laterals are often weakly developed and only one inferior median keel is present. This makes seven possible keels, instead of 10 as on segments I-IV. Generally the available keels bear well developed ornamentations which frequently have considerable taxonomic importance. The color and setaceous condition of this segment sometimes varies markedly from I-IV. At the ventro-distal end of segment V is found the anal arch. This often bears an anterior and posterior transverse crest (Fig. 10). The absence, presence and/or shape of the denticles on these crests, as well as the macrochaetes in the intercrestal area, are sometimes of taxonomic interest. Vachon (1952)

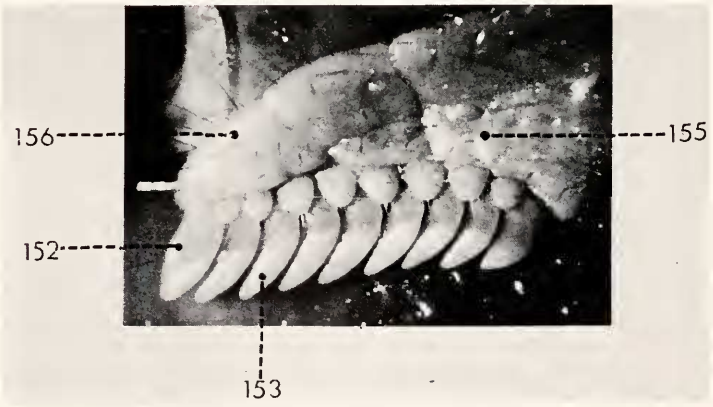

Figure 9. Scorpio maurus de Geer ventral surface right pecten. Light area (153) densely covered by sensilla.

Table 1. **Scorpion Nomenclature and Mensuration** *(Part 1)*

Code Nos.	Recommended Nomenclature	Equivalents: French	German	Spanish
1.	I. Trunk (cephalothorax + preabdomen or proaoma + mesosoma)	1. Tronc	1. Truncus	1. Tronco
2.	II. Prosoma (cephalothorax)	2. Céphalothorax	2. Cephalothorax	2. Cefalotórax
3.	A. Dorsal	3. Face dorsal	3. Dorsal (Rucken-flache)	3. Dorsal
4.	1. Carapace (scutum)	4. Bouclier	4. Ruckenschield	4. Carapacho
5.	a. Configuration	5.	5.	5. Contorno del carapacho
6.	1) Anterior margin	6. Front	6.	6. Depresion anterior muesca media anterior
7.	2) Frontal lobes	7.	7. Stirnloben	7. Lobulos frontales
8.	3) Anterior-posterior divergence	8.	8.	8. Divergencia antero-posterior
9.	b. Eyes	9.	9.	9. Ojos
10.	1) Lateral eyes (ocelli)	10. Yeux lateraux	10. Seitenaugen	10. Ojos laterales
11.	2) Ocular tubercle	11. Tubercule oculaire	11. Augenhugel	11. Tuberculo ocular
12.	a) Median eyes (central eyes)	12. Yeux medians	12. Mittelaugen	12. Oculi principales (ojos medios)
13.	b) Supercilliary crests	13.	13. Superciliarwulst	13. Crestas superciliares
14.	3) Interocular triangle (frontal area, anteocular triangle)	14.	14.	14. Triangulo interocular
15.	c. Furrows	15. Sillon	15. Furche (Rinne)	15. Surco (acanalado)
16.	1) Anterior marginal	16.	16.	16. Marginal anterior
17.	2) Anterior median	17.	17.	17. Medio anterior
18.	3) Median ocular	18.	18.	18. Ocular medio
19.	4) Lateral ocular	19.	19.	19. Ocular lateral
20.	5) Central lateral	20.	20.	20. Lateral central
21.	6) Central median	21.	21.	21. Central medio
22.	7) Central transverse	22.	22.	22. Central transverso
23.	8) Posterior transverse	23.	23.	23. Posterior transverao
24.	9) Posterior median	24.	24.	24. Medio posterior
25.	10) Posterior marginal	25.	25.	25. Marginal posterior
26.	11) Posterior lateral	26.	26.	26. Lateral posterior
27.	d. Keels	27. Carenes	27. Kielen	27. Quillas, cristae
28.	1) Anterior median	28. Médiales oculaires	28. Vorderer medial	28. Media anterior (anteriores medias)
29.	2) Supercilliary	29. Part of: médiales oculaires	29. Superciliarwulst	29. Superciliar
30.	3) Lateral ocular	30. Laterales oculaires	30. Vorderer lateral	30. Ocular lateral
31.	4) Centrel median	31. Médiales centrales	31. Mittlerer medial	31. Central media
32.	5) Central lateral	32. Laterales centrales	32. Mittlerer lateral	32. Central lateral
33.	6) Posterior median	33. Médiales postérieures	33. Hinterer medial	33. Posterior media
34.	7) Posterior lateral	34. Latérales postérieures	34. Hinterer lateral	34. Posterior lateral
35.	B. Ventral	35. Face ventrale	35. (Bauchseite) (Bauch-standig) ventral	35. Ventral
36.	1. Sternum	36. Sternum	36. Sternum	36. Esternón
37.	a. Shape	37. Forme	37. Gestalt	37. Configuración
38.	b. Median furrow	38. Sillon medians	38. Median-furche	38. Surco medio
39.	c. Basel pit	39.	39.	39. Foso anterior
40.	2. Appendages	40. Appendices	40. Anhange	40. Apéndices
41.	a. Chelicerae (Mandibulae)	41. Chéliceres	41. Mandibeln (Oberkiefer, Kiefernfubler)	41. Queliceros (cheliceres)
42.	1) Basal segment	42. Article de base	42. Basalglied	42. Segmento basilar (Basal)
43.	2) Chela	43. Pince	43. Mandibeln	43. Quela
44.	a) Manus (hand)	44. Main	44. Hand	44. Mano
45.	b) Fingers	45. Doigt	45. Mandibulsrfingers	45. Dedos
46.	(1) Fixed	46. Fixe	46. Unbeweglichen	46. Fijo (Oedoinmóvil o apófisis)
47.	(2) Movable	47. Mobile	47. Beweglichen	47. Movil (Segmento distal o dedomóvil)
48.	b. Pedipalps (palps, maxillary)	48. Pattes-mâchoires	48. Maxillarpalpen (Kiefern taster, Unterkiefer	48. Pedipalpos (Quelo, palpos, palpos maxilarea)
49.	1) Coxa	49. Hanches	49. Coxen (Huften)	49. Coxa
50.	2) Trochenter	50. Trochanter	50. Trochanter	50. Trocanter
51.	3) Femur (humerus, forearm)	51. Avant bras (Prefemur)	51. Femur (Oberarm) (Humerus)	51. Femur
52.	a) Surfaces	52. Faces	52. Flachen	52.
53.	(1) Dorsal	53. Face dorsale	53. Oberflache	53.
54.	(2) Ventral	54. Face ventrale	54. Unterflache	54.

Table 1. **Scorpion Nomenclature and Mensuration** *(Part 2)*

Code Nos.	Recommended Nomenclature	Equivalents		
		French	German	Spanish
55.	(3) Interior	55. Face interne	55. Vorderflache	55.
56.	(4) Exterior	56. Face laterale	56. Hinterflache	56.
57.	b) Keels	57. Carenes	57. Kielen	57.
58.	(1) Dorso-interior	58. Dorsal interne	58. Vorderrandkiel	58.
59.	(2) Dorso-median	59.	59.	59.
60.	(3) Proximo-marginal	60. Pédiculaire	60.	60.
61.	(4) Dorso-exterior	61. Dorsale externe	61. Hinterrandkiel	61.
62.	(5) Exterio-median	62.	62.	62.
63.	(6) Ventro-exterior	63.	63.	63.
64.	(7) Ventro-interior	64. Ventrale interne	64.	64.
65.	4) Patella (brachium, tibia)	65. Bras (Femur) (Tibia)	65. Tibia (Unterarm)	65. Tibia (Patela
66.	a) Surfaces	66. Faces	66. Flachen	66.
67.	(1) Dorsal	67. Dorsale	67. Oberflache	67.
68.	(2) Ventral	68. Ventrale	68. Unterflache	68.
69.	(3) Interior	69. Interne	69. Vorderflache	69.
70.	(4) Exterior	70. Externe	70. Hinterflache	70.
71.	b) Keels	71. Carenes	71. Kielen	71. Quillas
72.	(1) Dorso-interior	72. Interne dorsale	72. Vorderrandkiel	72.
73.	(2) Dorsal	73. Dorsale	73.	73.
74.	(3) Dorso-median	74. Médian dorsale	74.	74.
75.	(4) Dorso-exterior	75. Laterále dorsale	75. Hinterrandkiel	75.
76.	(5) Exterior-median	76. Externe	76.	76.
77.	(6) Ventro-exterior	77. Laterále ventrale	77.	77.
78.	(7) Ventro-median	78. Médiane ventrale	78.	78.
79.	(8) Ventro-interior	79. Interne ventrale	79.	79.
80.	5) Chela (pincers)	80. Main (Tibio-tarsus)	80. Schere	80. Quela (Tenazas)
81.	a) Tibia	81. Tibio	81.	81. Tibia (Mano)
82.	(1) Manus (hand)	82. Main	82. Hand	82. Mano
83.	(2) Finger (fixed finger)	83. Doigt fixe	83. Unbeweglichen	83. Dedo inmovil
84.	b) Tarsus (movable finger)	84. Doigt mobile (post-tarse)	84. Beweglichen	84. Dedo movil (Tarso)
85.	c) Superior surface	85. Face externe	85. Oberhand	85. Cara superior
86.	(1) Keels	86. Carenes	86. Kielen	86. Quillas
87.	(a) Exterior marginal	87. Ventral extreme	87. Aussenrandkiel	87. Arista exterior
88.	(b) Secondary accessory	88. Ventral accessoire	88.	88.
89.	(c) Exterior secondary	89. Médiane	89. Aussennebenkiel	89. Auxiliares superiores
90.	(d) Digital	90. Intermédiaire	90. Fingerkiel	90. Digital
91.	(e) Sub-digital	91.	91.	91.
92.	(f) Inner secondary	92. Dorsal accessoire	92. Innennebenkiel	92. Secundaria interna
93.	(g) Subinner secondary	93.	93.	93.
94.	(h) Interior marginal	94. Dorsal axiale	94. Innenrandkiel	94. Arista interior
95.	(2) Areas	95.	95. Flachen	95.
96.	(a) Inner	96.	96. Innenflache	96.
97.	(b) Exterior	97.	97. Aussenfläche	97.
98.	d) Inferior surface	98. Face interne	98. Unterflache	98. Cara inferior
99.	(1) Keels	99. Carénes	99. Kielen	99. Quillas
100.	(a) Exterior marginal	100. Ventral interne	100. Aussenrandkiel	100. Arista exterior
101.	(b) Exterior secondary	101. Médiane	101. Aussennebenkiel	101. Auxiliares superiores
102.	(c) Digital	102. Intermediaire	102. Fingerkiel	102. Digital
103.	(d) Inner secondary	103. Dorsal accessoire	103. Innennebenkiel	103. Secundaria interna
104.	e) Exterior surface	104. Face ventrale	104. Hinterhand	104. Cara exterior
105.	f) Cutting edges of fingers	105. Face interne	105. Schneide	105.
106.	(1) Median granules (median series)	106.	106.	106. Granulos medios
107.	(a) One long row	107.	107. Einfache reihe	107.
108.	(b) Series of rows	108.	108. Reihenfolge	108.
109.	(c) Non-imbricated oblique rows	109.	109. Non-dachziegelartig Schrägreigen	109.
110.	(d) Imbricated oblique rows	110.	110. (Uberreinander greifenden) Dachziegelartig Schrägreihen	110.

Table 1. **Scorpion Nomenclature and Mensuration** *(Part 3)*

Code Nos.	Recommended Nomenclature	Equivalents		
		French	German	Spanish
111.	(2) External lateral granules (outer series)	111.	111. Aussere Seitenkornchen	111. Granulos externos laterales
112.	(3) Internal lateral granules (inner series)	112.	112. Inner Seitenkornchen	112. Granulos laterales internos
113.	(4) Supernumerary granules	113.	113. Uberzahlige Kornchen	113. Granulos supernumera
114.	(5) Lobes	114. Lobes	114. Loben	114. Lobulos
115.	6) Trichobothria	115. Trichobothries	115. Trichobothrien (Horhaar)	115. Tricobotrias
116.	c. Walking legs	116. Pattes ambulatoires	116. Laufbeinen	116. Patas (Caminadoras)
117.	1) Coxa	117. Hanches	117. Coxen (Huften)	117.
118.	a) Coxal endite 1 (maxillary lobes I)	118. Processus maxillaires I	118. Maxillarfortsatz I	118. Lóbulos maxilares I
119.	b) Coxal endite II (maxillary lobes II)	119. Processus maxillaires II	119. Maxillarfortsatz II	119. Lóbulos maxilares II
120.	2) Trochanter	120. Trochanter	120. Trochanter	120. Trocanter
121.	3) Femur	121. Prefemur	121. Femur (Schenkel)	121. Fémur
122.	4) Patella (tibia)	122. Femur	122. Tibia (Schiene)	122. Tibia (Patella)
123.	5) Tibia (metatarsus)	123. Tibia	123. Tarsengliede I	123. Metatarsus
124.	a) Tibial spur	124. Eperon tibial	124. Tarsalsporn	124. Espolon (Calcar)
125.	6) Tarsus	125. (Tarse)	125. (Tarsenglieder)	125. Tarso
126.	a) Tarsomere I	126. Basitarse	126. Tarsengliede II	126. Pretarsus (Tarsómero I)
127.	(1) Pedal spurs	127. Eperon basitarsaux	127. Grunddorn	127. Espina tarsus
128.	(2) Bristle comb	128. Pecten	128.	128.
129.	b) Tarsomere II	129. Tarse	129. Tarsengliede III	129. (Tarsómero II)
130.	(1) Inferior spines or pads and/or bristles	130. Epines ou coussinets et/ou de soies	130. Unter dornen, wulste un/oder haar	130.
131.	(2) Median lobe (tarsal process, unguicular lobe)	131. Languette tarsale	131. Krallenlappen	131. Lobulo unguicular
132.	(3) Lateral lobes (terminal lobes)	132. Lobe tarsale	132. Endloben	132. Lobulos terminales laterales
133.	7) Pretarsus (epitarsus)	133. Post-tarse	133.	133. Pretarsus
134.	a) Lateral claws (ungues)	134. Griffes	134. Krallen (Endkrallen)	134. Uñas
135.	b) Median claw (dactyl, unguicular spine)	135. Talon	135. Gehstachel	135. Espina unguicular
136.	III. Opisthosoma (abdomen + telson)	136. Opisthosoma	136. Opisthosoma	136. Opistosoma (Abdomen)
137.	A. Mesosoma (preabdomen)	137. Mesosoma (abdomen)	137. Mesosoma (Abdomen)	137. Mesosoma (Preabdomen)
138.	1. Dorsal	138. Face dorsale	138. Dorsal (Ruckenseite)	138. Dorsal
139.	a. Tergites (I-VII) (terga)	139. Tergite	139. Ruckenplatten	139. Tergitos
140.	1) Pretergites	140. Prétergite	140.	140.
141.	2) Keels	141. Carénes	141. Kielen	141. Quillas
142.	a) Median	142. Axiale	142. Medial kiele	142. Medias
143.	b) Median laterals	143. Laterale	143. Seitenkiele	143. Laterales
144.	c) Lateral	144. Laterale	144. Seitenkiele	144. Laterales
145.	2. Ventral	145. Face ventrale	145. Ventral (Bauchseite)	145. Ventral
146.	a. Genital operculum (I)	146. Opercules genitaux	146. Genital klappe	146. Opercula genital (I)
147.	1) Gonotreme (genital aperture)	147. Ouverture génitale	147.	147. Gonotrema
148.	2) Genital papillae	148. Crochets copulateurs	148.	148. Papilas genitales
149.	b. Post-genital fold	149.	149.	149.
150.	c. Basal piece (II)	150. Plaque pectinifere	150. Kammgrundstuck	150. Lamina Basilar (II)
151.	1) Pectens (pectines; Sing. pecten)	151. Peignes	151. Kamme	151. Peines
152.	a) Teeth	152. Dents (lamelles)	152. Kammzahne	152. Dentes
153.	(1) Sensilla	153.	153. Sinnesborsten	153.
154.	b) Fulera	154. Fulcres	154. Fulera	154. Fulcros
155.	c) Middle lamellae	155. Pièces médianes	155. Mittllamellen	155. Laminas medias
156.	d) Marginal lamellae	156. Pieces dorsales	156. Randlamellen	156. Laminas marginales

Table 1. **Scorpion Nomenclature and Mensuration** *(Part 4)*

Code Nos.	Recommended Nomenclature	Equivalents		
		French	German	Spanish
157.	d. Post-basal fold	157.	157.	157.
158.	e. Sternites (III-VII)	158. Sternite	158. Bauchenplatten	158. Esternitos (III-VII)
159.	1) Pre-sternite	159. Presternite	159.	159.
160.	2) Stigmata (spiracles)	160. Stigmate	160. Stigmen	160. Estigmas (Espiraculos)
161.	3) Keels (VII)	161. Carénes	161. Kielen	161. Quillas (VII)
162.	3. Pleural membranes	162. Pleurum abdominal	162.	162.
163.	B. Metasoma (cauda, tail, postabdomen + telson)	163. Metasoma (queue)	163. Cauda (Postabdomen)	163. Metasoma (Cola a postabdomen)
164.	1. Postabdomen	164. Postabdomen	164. Postabdomen	164. Postabdomen
165.	a. Segments I-IV (XV-XIX)	165. Anneaux 1-IV	165. Ringen 1-IV	165. Segments 1-IV
166.	1) Dorsal furrow	166. Gouttière (Concavite dorsale)	166. Oorsalrinne	166. Surco dorsal
167.	2) Keels	167. Carénes	167. Kielen	167. Quillas
168.	a) Dorsals	168. Dorsales	168. Dorsalkiele	168. Dorsal
169.	b) Superior laterals	169. Latérale-dorsale	169. Oberer lateralkiele	169. Laterales superiores
170.	c) Median laterals	170. Intermédiaire	170. Nebenkiele	170. Laterales medias
171.	d) Inferior laterals	171. Latérale-ventrale	171. Untere lateralkiele	171. Lateral inferiores
172.	e) Inferior medians	172. Ventrale	172. Unteren medialkiele	172. Medias inferiores
173.	b. Segment V	173. Anneau V	173. Ringe V	173. Segmento V
174.	1) Keels	174. Carénes	174.	174.
175.	a) Superior laterals	175. Latérale-dorsale	175. Oberer lateralkiele	175. Laterales superiores
176.	b) Inferior laterals	176. Latérale-ventrale	176. Untere lateralkiele	176. Lateral inferiores
177.	c) Inferior median	177. Axiale	177. Unteren medialkiele	177. Media inferiore
178.	2) Anal arch	178. Cadre anal	178.	178. Arco anal
179.	a) Anterior crest	179.	179.	179. Cresta anterior
180.	b) Posterior crest	180.	180.	180. Cresta posterior
181.	c) Intercrestal area	181.	181.	181. Area intercrestal
182.	3) Anal papilla	182. Papilles anales	182.	182.
183.	c. Intercarinal areas	183.	183.	183. Espacio intercarenaus
184.	2. Telson	184. Telson	184.	184. Telson
185.	a. Peduncle (pedicle)	185. Pedicule	185.	185. Pedunculo
186.	b. Pedicular plate	186. Plaque pediculaire	186.	186. Opercule anal
187.	c. Vesicle (ampulla)	187. Vésicule	187. Blase	187. Vesicula
188.	d. Aculeus (sting)	188. Aiguillon	188. Stachel	188. Aguijón
189.	e. Subaculear tubercle or tooth	189. Dent sous l'aiquillon	189. Stachel Dorn oder Hocker	189. Diente subaculear
190.	C. Miscellany	190. Miscellanées	190. Miszellaneen	190. Miscelanea
191.	1. Surface features	191. Traits de surface	191. Aussenseite Kennzeichen (Skulptur des chitinpanzers)	191. Facciones superficie
192.	a. Smooth	192. Lisse	192. Glatt	192. Lisa
193.	b. Punctate	193. Pointillé	193. Punktiert	193. Puntuado
194.	c. Immovable projections	194. Projection fixe	194. Umbeweglichen ausbildungen	194. Proyecciones inmoviles
195.	1) Granules	195. Granules	195. Kornchen	195. Gránulos
196.	2) Tubercles	196. Tubercules	196. Höcker	196. Tuberculos
197.	3) Spines	197. Epines	197. Dornen	197. Espinas
198.	4) Denticles	198. Denticules	198. Zahnchen	198. Denticulos
199.	d. Movable projections	199. Projection mobile	199. Beweglichen ausbildungen	199. Proyecciones móviles
200.	1) Setae	200. Soies	200. Borsten	200. Sedas
201.	a) Macrochaetes	201. Macrochete	201. Makroborsten	201. Macrosedas
202.	b) Microchaetes	202. Microchète	202. Mikroborsten	202. Microsedas
203.(115)	c) Trichobothria	203. Trichobothria	203. Trichobothrien (Horhaar)	203. Tricobotrias
204.	e. Reticulums	204. Reticulums	204. Netzwerken	204. Reticulaciones
205.	1) Costate	205. Côte (carène)	205. Gerippt	205. Costifero
206.	2) Pigmented	206. Pigmenté	206. Pigmenthaltig	206. Pigmentada
207.	3) Punctate	207. Pointillé	207. Punktiert	207. Puntuado
208.	f. Color	208. Colour	208. Farbe	208. Color

classifies the anal arch into three forms: Circular lobed, circular regular and angular. In some taxa, the inferior median keel does not extend to the anal arch. Instead it may fork, or a crescentic arrangement of denticles may be present. This crescent and the enclosed area varies at both the generic and species level in some families.

The intercarinal areas of all segments may bear important surface features, such as, size and density of granules, presence of costate or pigment reticulations and setaceous patterns.

The telson is quite variable in the three dimensions of the vesicle, the surface features and the length, taper, and curvature of the aculeus, as well as the absence or presence of a subaculear tooth or tubercle (Fig. 10).

The length of the cauda is reported in various ways. This may consist of the over-all length of the abdominal segments only or including the telson. This is not a valid measurement because this over-all length is dependent on the degree of relaxation of the intersegmental tissue. The most accurately reproducible and valid method is to take the sum total of the non-telescoping portion of each segment plus the length of the telson. This latter measure-

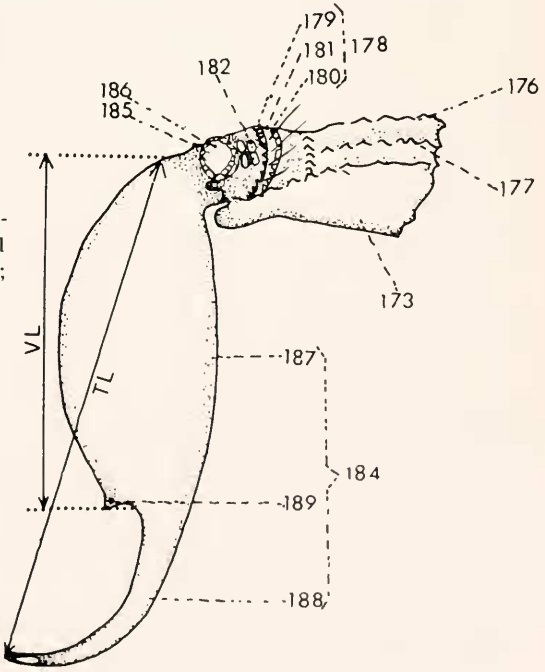

Figure 10. Generalized telson and distal end of caudal segment V. TL=Telson Length; VL=Vesicle Length.

ment is the shortest distance between the "heel" of the vesicle and the tip of the aculeus (Fig. 10). Height and width measurements of the segments consist of the largest distance between margins of the segment proper. Thus the measurements would not extend to the extremities of any large abrupt, protuberances but rather near their base. Measurements of this type obviously cannot be precise.

In the description of taxon surface features the terminology used is often inaccurate and/or too general. An example is the term rugose, which literally means wrinkled. Some authors have used it to mean any rough, coarse surface. Frequently, the surface was costate reticulate or coarsely tuberculate or punctate. Kraepelin occasionally resorted to picturesque terminology which left the novice in a quandry. For example, he describes the middle lamellae of some pectens as resembling a string of pearls (*perlschnurartig*). Precisely he meant a series of vaulted sclerotized circular plates. Expressions of color are misleading. For example, the term melanic. The biochemist tells us that melanins are a series of pigments ranging from brown through black. Thus the term melanic is not adequately precise. Other undesirable color expressions are: ochroid, caledonian brown, flesh, tanbark, geranium, etc.

The nomenclature here introduced for surface features (191-208) are in sufficient use to give them a relatively precise meaning. It is true that in some cases, as in granules and tubercles, we have a matter of subjectiveness. Also, "granule" has a generic connotation including tubercles. However, the general context and adjectives, such as minute, fine, and coarse, provide clarification. There should be no difficulty with the use of granule versus denticle. More care should be exercised in describing the immovable projections on the cutting edges of the pedipalp chela. Here one finds rows of granules or tubercles as well as an accompanying denticulate condition (Figs. 6 and 7). The same situation may be found on the keels of both pedipalp and caudal segments. These may have generic or specific significance.

The only movable projections of great taxonomic value are the trichobothria (Fig. 5). These are found only on the femur, patella and tibia of the pedipalps. Their number and patterns are relatively constant and the distances between them can be measured very precisely. They are valuable even in old, poorly preserved specimens since even though the bristle is lost, the cup-like aroela from which it arises is readily recognized. Macrochaetes, the large non-sensory setae, also leave a somewhat cup-shaped areola but the bristle base completely fills the inner space while that of the trichobothria does not. Also, the lip of the trichobothrial areola is generally whitish.

The trichobothria intact are readily recognized from other setae. The bristle is very long and thin, reacts to the slightest movement of air and is not

readily broken off. The shaft of the ordinary setae is much thicker at the base, generally shorter, stiff and fragile. Only under special circumstances do they have taxonomic value and less so on old, poorly preserved material.

The macrochaetes are heavy bodied, stiff, colored; they arise from a relatively areolar cup which is completely filled by the vase of the bristle. Microchaetes are whitish, small, fine bristles with a base attached to a poorly developed areolar cup.

Reticular patterns are often encountered, either due to pigment, punctations or a costate condition. In some taxa the pigment reticulum of the juvenile forms is gradually replaced by the costate condition as a consequence of maturation. Frequently the costate condition is part of the pattern of sexual dimorphism.

Color is often a deceiving taxonomic trait. The pattern and shade of color may vary with maturation and hybridization. Consequently, its importance should be viewed with caution. However, when color of a taxon or specimen is described, simplicity of expression is most effective. Use of the primary colors in a variable manner is most likely to convey as precise a concept as is necessary. Vachon has set an excellent example in this respect. Color codes, because of the variety of surface conditions and the consequent light reflectivity are not very satisfactory.

The list-outline of nomenclature provided in Table 1, besides improving communication, will serve also as a valuable check-list when describing a new taxon or making a comparative study of several taxa. This will permit the specialist to be more selective in choosing descriptive data and prevent long, redundant descriptions. The quantitative data made possible from the above suggestions can also supply excellent data for population studies and move away more rapidly from the old typological species concept.

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3.0076. Scorpion nomenclature and mensuration. Abstract.—The check-list, illustrations, and descriptions of the anatomy of scorpions make possible accurate measurements, descriptions of taxa, and uniformity of scorpion nomenclature.—**Herbert L. Stahnke,** *Poisonous Animals Research Laboratory, Arizona State University, Tempe, AZ 85281.*

Descriptors: Scorpion; Scorpionida; anatomical terminology; mensuration.